

CLAIMS

1. A method of measurement, said method comprising:
using a first sensor to measure at least one height of a first portion of a substrate;
using a second sensor to measure at least one height of the first portion of the substrate;
generating a first characterization of an offset error of the first sensor, based on the at least one height measured using the first sensor and the at least one height measured using the second sensor;
using the first sensor to measure a plurality of heights of a second portion of a substrate; and
generating a second characterization of the second portion of a substrate, based on the first characterization and the plurality of heights of the second portion of a substrate.
2. The method of measurement according to claim 1, wherein the first portion and the second portion are portions of the same substrate.
3. The method of measurement according to claim 1, wherein the first portion and the second portion are portions of different substrates.
4. The method of measurement according to claim 1, said method further comprising exposing a substrate based on the second characterization.
5. The method of measurement according to claim 4, said method further comprising, prior to said exposing, storing the second characterization.

6. The method of measurement according to claim 4, wherein said generating a second characterization occurs during said exposing.

7. The method of measurement according to claim 4, wherein said exposing a substrate includes controlling a position of the substrate based on the second characterization.

8. The method of measurement according to claim 4, wherein said exposing a substrate includes projecting a patterned beam of radiation onto a target portion of the substrate to be exposed,
wherein the target portion is at least partially covered by a layer of radiation-sensitive material.

9. The method of measurement according to claim 1, wherein the second characterization includes a height map.

10. The method of measurement according to claim 1, said method further comprising:

using the first sensor to measure a first plurality of heights of portions of different substrates;

using a second sensor to measure a second plurality of heights of the portions of different substrates;

wherein said generating a first characterization is based on the first and second pluralities of heights.

11. The method of measurement according to claim 10, wherein said first portion includes a plurality of subportions of a substrate.

12. The method of measurement according to claim 1, wherein said using a first sensor to measure at least one height of a first portion of a substrate includes measuring a height based on at least one of an optical property of the first portion and an electrical property of the first portion.

13. The method of measurement according to claim 1, wherein said using a second sensor to measure at least one height of a first portion of a substrate includes measuring a height based on a property of the first portion other than an optical property and other than an electrical property.

14. The method of measurement according to claim 1, wherein the first sensor is a process dependent sensor.

15. The method of measurement according to claim 1, wherein the first sensor is a process dependent sensor having a first process dependency, and the second sensor is process dependent sensor, having a second process dependency, different from the first process dependency.

16. The method of measurement according to claim 1, wherein the second sensor is a process independent sensor.

17. The method of measurement according to claim 1, wherein said using a second sensor to measure at least one height of a first portion includes using at least one of an air gauge, an external profiler, and a scanning needle profiler to measure a height of the first portion.

18. The method of measurement according to claim 1, wherein said using a first sensor to measure at least one height of a first portion of a

substrate includes measuring a height based on one of an optical property of the first portion and an electrical property of the first portion, and

wherein said using a second sensor to measure at least one height of a first portion of a substrate includes measuring a height based on the other of an optical property of the first portion and an electrical property of the first portion.

19. The method of measurement according to claim 1, wherein the first characterization and the second characterization are both based on measurements performed within a predetermined part of the surface of the substrate.

20. The method of measurement according to claim 19, wherein a further first characterization and a further second characterization are generated both based on a measurement performed within a predetermined further part of the surface of the substrate.

21. The method of measurement according to claim 1, wherein the first characterization is determined based on a measurement performed on a first portion of a substrate, and a second characterization is determined based on a measurement performed on a second portion of the substrate and further characterizations are determined based on an interpolation of the first and the second characterization.

22. The method of measurement according to claim 1, wherein first characterization of an offset error is determined for a first group of substrates, and a further first characterization is determined for a second group of substrates, based on the first characterization of the offset error for the first

group of substrates and measurements performed by the first and second sensors to measure at least one height of a substrate of the second group of substrates.

23. A device manufactured according to the method according to claim 1.

24. A method of measurement, said method comprising:
using a first sensor to measure at least one height of a first portion of a substrate;

using an in resist focus determination to measure at least one height of the first portion of the substrate;

generating a first characterization of an offset error of the first sensor, based on the at least one height measured using the first sensor and the at least one height measured using the in resist focus determination;

using the first sensor to measure a plurality of heights of a second portion of a substrate; and

generating a second characterization of the second portion of a substrate, based on the first characterization and the plurality of heights of the second portion of a substrate.

25. The method of measurement according to claim 24, the height measured using the in resist focus determination is based on a result of using at least one of a focus exposure matrix and a focus-sensitive mark.

26. The method of measurement according to claim 24, wherein the first portion and the second portion are portions of the same substrate.

27. The method of measurement according to claim 24, wherein the first portion and the second portion are portions of different substrates.

28. The method of measurement according to claim 24, said method further comprising exposing a substrate based on the second characterization.

29. The method of measurement according to claim 28, said method further comprising, prior to said exposing, storing the second characterization.

30. The method of measurement according to claim 28, wherein said generating a second characterization occurs during said exposing.

31. The method of measurement according to claim 28, wherein said exposing a substrate includes controlling a position of the substrate based on the second characterization.

32. The method of measurement according to claim 24, wherein the second characterization includes a height map.

33. The method of measurement according to claim 24, said method further comprising:

using the first sensor to measure a first plurality of heights of portions of different substrates;

using the in resist focus determination to measure a second plurality of heights of the portions of different substrates;

wherein said generating a first characterization is based on the first and second pluralities of heights.

34. The method of measurement according to claim 33, wherein said first portion includes a plurality of subportions of a substrate.

35. The method of measurement according to claim 24, wherein said using a first sensor to measure at least one height of a first portion of a substrate includes measuring a height based on at least one of an optical property of the first portion and an electrical property of the first portion.

36. The method of measurement according to claim 24, wherein the first sensor is a process dependent sensor.

37. A lithographic apparatus comprising:
a first sensor configured to measure at least one height of a first portion of a substrate and to measure a plurality of heights of a second portion of a substrate;
a second sensor configured to measure at least one height of the first portion of the substrate;
a processor configured (1) to generate a first characterization of an offset error of the first sensor, based on the at least one height measured using the first sensor and the at least one height measured using the second sensor; and (2) to generate a second characterization of the second portion of a substrate, based on the first characterization and the plurality of heights of the second portion of a substrate.

38. The lithographic apparatus according to claim 37, said apparatus further comprising a patterning structure configured to pattern a beam of radiation according to a desired pattern;
a substrate table configured to hold a substrate;
a projection system configured to project the patterned beam onto a target portion of a substrate held by the substrate table,
wherein the apparatus is configured to position the substrate table based on the second characterization.

39. The lithographic apparatus according to claim 38, said apparatus further comprising a radiation system configured to provide the beam of radiation.

40. The lithographic apparatus according to claim 37, wherein the target portion is at least partially covered by a layer of radiation-sensitive material.

41. The lithographic apparatus according to claim 37, wherein said first sensor is configured to measure a height of the first portion based on at least one of an optical property of the first portion and an electrical property of the first portion.

42. The lithographic apparatus according to claim 37, wherein said second sensor is configured to measure a height of the first portion based on a property of the first portion other than an optical property and other than an electrical property.

43. The lithographic apparatus according to claim 37, wherein the first sensor is a process dependent sensor.

44. The lithographic apparatus according to claim 37, wherein the second sensor is a process independent sensor.

45. The lithographic apparatus according to claim 37, said apparatus further comprising a memory unit configured to store at least one of the first and second characterizations.

46. A data storage medium including instructions describing a method of measurement, said method comprising:

using a first sensor to measure at least one height of a first portion of a substrate;

using a second sensor to measure at least one height of the first portion of the substrate;

generating a first characterization of an offset error of the first sensor, based on the at least one height measured using the first sensor and the at least one height measured using the second sensor;

using the first sensor to measure a plurality of heights of a second portion of a substrate; and

generating a second characterization of the second portion of a substrate, based on the first characterization and the plurality of heights of the second portion of a substrate.

47. A method of measurement using a first and a second sensor, said method comprising:

using the second sensor to measure a contour of at least one mark positioned on a substrate;

generating a characterization of an offset error of the first sensor, based on the measurement of the at least one mark using the second sensor;

determining a position of a mark based on a measurement by the first sensor and the characterization.

48. A method of measurement according to claim 47, wherein the second sensor is one of: tunneling microscope and a surface profile measuring.

49. A device manufactured according to the method according to claim 47.

50. A lithographic apparatus comprising:
a first sensor being arranged for measuring positions of marks positioned on a substrate;
a second sensor being arranged for measuring a contour of at least one mark positioned on a substrate;
a processor being arranged for generating a characterization of an offset error of the first sensor, based on at least one measurement of the second sensor; and to determine a position of a mark, based on a measurement by the first sensor and the characterization.

51. A data storage medium including instructions describing a method of measurement using a first sensor and a second sensor, said method comprising:

using the second sensor for measuring a contour of at least one mark positioned on a substrate;

generating a characterization of an offset error of the first sensor, based on the measurement of the at least one mark using the second sensor;
determining a position of a mark based on a measurement by the first sensor and the characterization.